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Study Indicates Fluid Digital Computation Systems Are Feasible

The use of fluid amplifiers with no moving parts for digital computation systems is of interest primarily because of their environmental tolerance and their expected long life (shelf and operating). Their tolerance to both nuclear and electromagnetic radiation and to extreme temperature ranges appears limited only by the fabrication material. Shock and vibration tolerance also appear excellent; fluid amplifiers have withstood vibration levels as high as 50g at 5000 cycles per second. Production costs of fluid amplifier components may be low because of the lack of close-fitting moving parts and bearing surfaces.

The digital integrator is the basic building block in digital differential analyzer (DDA) systems just as the operational amplifier serves as the basic building block in analog computational systems. Since the digital integrator (DI) is the basic building block for digital computation systems, it was chosen as the most appropriate component to investigate the feasibility of fluid amplifier implementation for such systems.

As a result of the study, the following conclusions and recommendations were made:

The results of this program are convincing that digital computation systems using fluid amplifiers are practical. The response speed of the fluid systems is adequate for many space applications; the potential for reliability in adverse environments such as nuclear radiation, heat, and vibration is superior to electronic circuitry. Typical applications which have been considered are a satellite attitude control, and a guidance computer for an escape "lifeboat" for manned orbital stations.

The work done on this project has dealt only with the digital integrator, since it was considered a key feasibility problem for digital systems. For any specific application it will be necessary to consider other parts of the system, such as power supply, sensors, displays and digital/analog converters. Investigation of these areas can be pursued most economically by considering specific application requirements.

As far as the digital integrator itself is concerned, the following represent areas where additional effort should be applied:

1. miniaturization
2. speed
3. power consumption
4. packaging design and fabrication techniques
5. instrumentation.

The work in these areas is closely interrelated. Miniaturization is required to improve speed and to reduce power consumption; the degree of miniaturization will affect the instrumentation requirements for monitoring and test, and will dictate certain fabrication methods. The package design must permit very close coupling of elements to achieve high operating speeds.

Complete details of this study are contained in: NASA Contractor Report, *Fluid Amplifier Digital Integrator,* prepared by General Electric, NASA, CR-61092, September 1965. Copies of this report are available from

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No patent action is contemplated by NASA.

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Category 01